Demand Control Ventilation
California Energy Efficiency Standards 2005

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DCV Study Scope

- Extension of occupancies
- System size limit
- CO2 control threshold
- Add design and verification requirements

DCV Comparison 121(c)3

- Existing Requirement
  - A. That primarily serve areas with fixed seating and occupant densities less than or equal to 10 square foot per person, or identified in Chapter 10 of the UBC as either "Assembly Areas, Concentrated Use (without fixed seats)" or "Auction Rooms." ; and
  - B. That have design outdoor air capacities equal to or exceeding 3,000 cfm.
- Proposed Requirement
  - A. They have an **outdoor air economizer**; and
  - B. They primarily serve a single room with a design occupant density greater than or equal to 25 people per 1000 ft^2 (**40 square foot per person**), or the room's occupancy type per Chapter 10 of the UBC is **"Assembly Areas," "Concentrated Use (without fixed seats)," "Auction Rooms," "Assembly Areas, Less-Concentrated Use," or "Classrooms."**

DCV Comparison 121(c)4

- Existing Requirement
  - A. Allow the rate of outdoor air to be reduced to 0.15 cfm per square foot of conditioned floor area if the demand control ventilation device indicates that the space conditions are acceptable; and
  - B. Be approved by the commission; and
  - C. If the device is a carbon dioxide sensor, limit the carbon dioxide level to no more than 800 ppm while the space is occupied; and

DCV Comparison 121(c)4

- Proposed Requirement
  - A. Be a CO2 sensor that has an accuracy of no less than 75 ppm, that is factory calibrated or calibrated at start-up, and that requires calibration no more frequently than once every 5 years. The sensor shall be located in the room between 1 ft and 6 ft above the floor;
  - B. Reduce outdoor air ventilation rates below the design outdoor air ventilation rate when the number of occupants in the space is below the design occupancy. The controls shall be set to provide no less than 15 cfm per person of outdoor air as calculated by Equation 1-X;
  - C. Maintain outdoor air ventilation rates no less than the rate listed in Table 1-F times the conditioned floor area, regardless of occupancy, when the system is operating during hours of expected occupancy; and
  - D. Supply the design outdoor air ventilation rate when the sensor fails or provides a reading out of normal range.

121(c)4, Equation 1-X

(proposed requirement cont.)

$$R_p = \frac{8{,}400 \times m}{C_R - C_{OA}}$$

Where

R_p = *The rate of outdoor air per person (cfm/person)*

m = *The metabolic rate (1 met = 58.2 W/m^2). The default metabolic rate is 1.2 mets.*

C_{OA} = *The outdoor air CO_2 concentration (ppm). The default outdoor air CO_2 concentration is 400 ppm.*

C_R = The room CO_2 concentration (ppm) measured by the sensor.

Under default conditions 15 cfm/person ⇒ ~1,100 PPM CO2

DCV Costs

Table 1 . Vendor Cost Data for CO_2 Based DCV as an Addition to Airside Economizers

	Incremental Cost ($/system)	**Incremental labor (hrs/system)**
Vendor A	$310	0.5
Vendor B	$400	0.5- 1.0
Vendor C	$700	8-16

We used the following:

parts: $300 (+25% contractor markup)	$375
labor: 2 hours @ $100/hr	$200
TOTAL	$575

DCV Modeling

- DOE2 building model with single interior zone
- All 16 climate zones
- Flat occupancy schedule with 50% peak (see following slides)
- Single-zone packaged unit with air-side economizer
- 1.37 as the present value of a kilowatt-hour saved over a 15 year life
- $7.30 as the present value of a therm saved over a 15 year life

DCV Modeling

- Since the time of savings vary with the type of occupancy we assumed a flat occupancy schedule. We used a threshold of 50% full occupancy during all hours of operation to be consistent with the following schedules:
- Other schedules for comparison:
  - ASHRAE 90.1-1999 Schedule "C" (used for museum general exhibition, theater auditorium seating area, theater lobby, supermarket, library, etc.). During the hours of fan operation, this schedule has an average occupancy of 50%
  - ASHRAE 90.1-1999 Schedule "I" (used for assembly, religious, theater performing arts seating, etc.) During the hours of fan operation, this schedule has an average occupancy of 54%
  - ASHRAE 90.1-1999 Schedule "B" (used for hotel banquet, motel dining, cafeteria, etc.) During the hours of fan operation, this schedule has an average occupancy of 51%
  - ASHRAE 90.1-1999 Schedule "D" (used for classroom, laboratory, etc.) During the hours of fan operation, this schedule has an average occupancy of 52%
  - EQUEST – Secondary School Schedule. During the hours of fan operation, this schedule has an average occupancy of 41%
- ACM Non-Residential Occupancy Schedule. This schedule only achieves 50% peak occupancy at any time and 35% average occupancy at all "normally occupied" times but is multiplied by the full UBC exiting density. Since our three threshold occupant densities are based on ½ the UBC exiting density numbers we had to rescale the ACM schedule by a factor of 2. Its resulting average occupancy is 70%.

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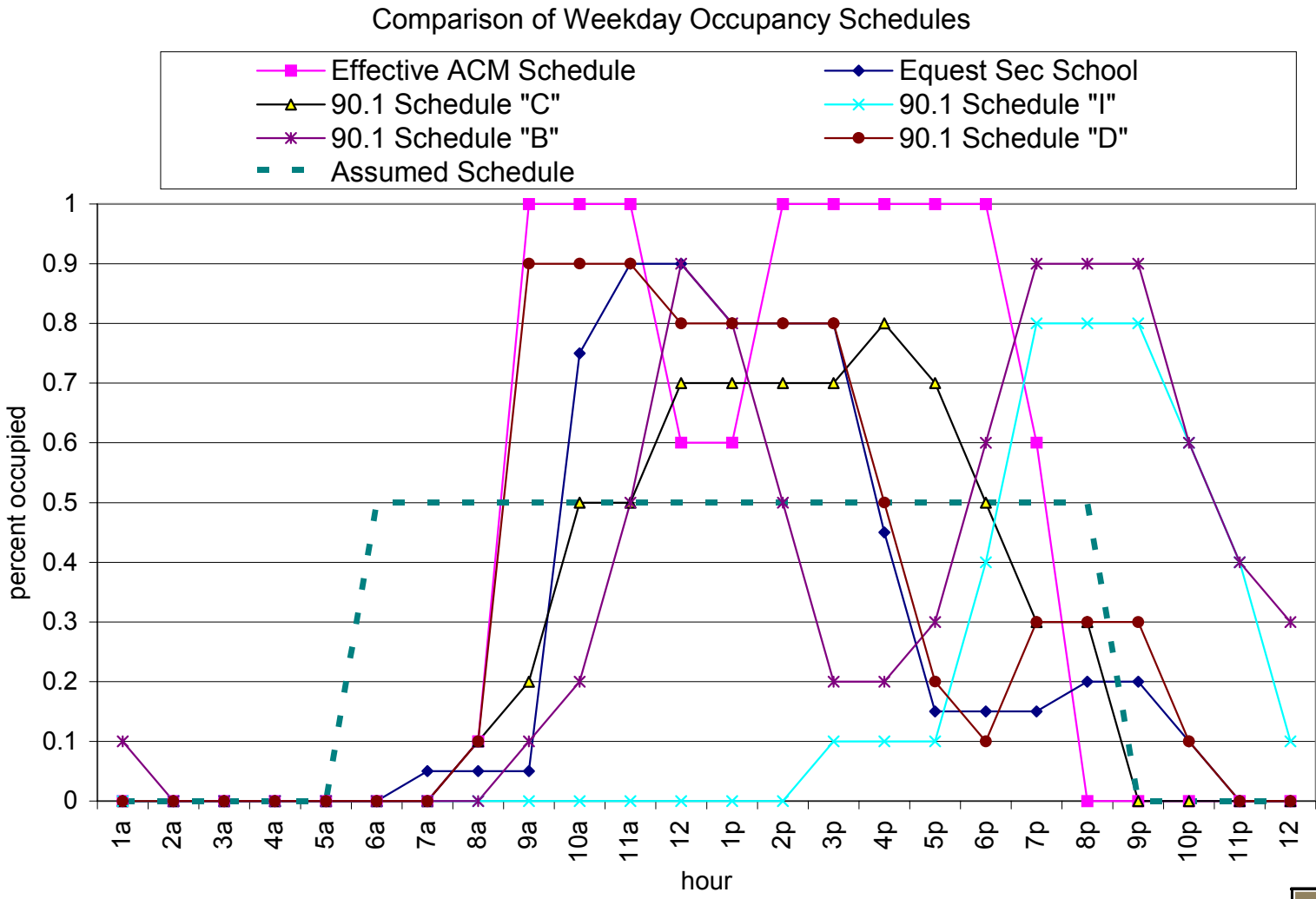
DCV Modeling



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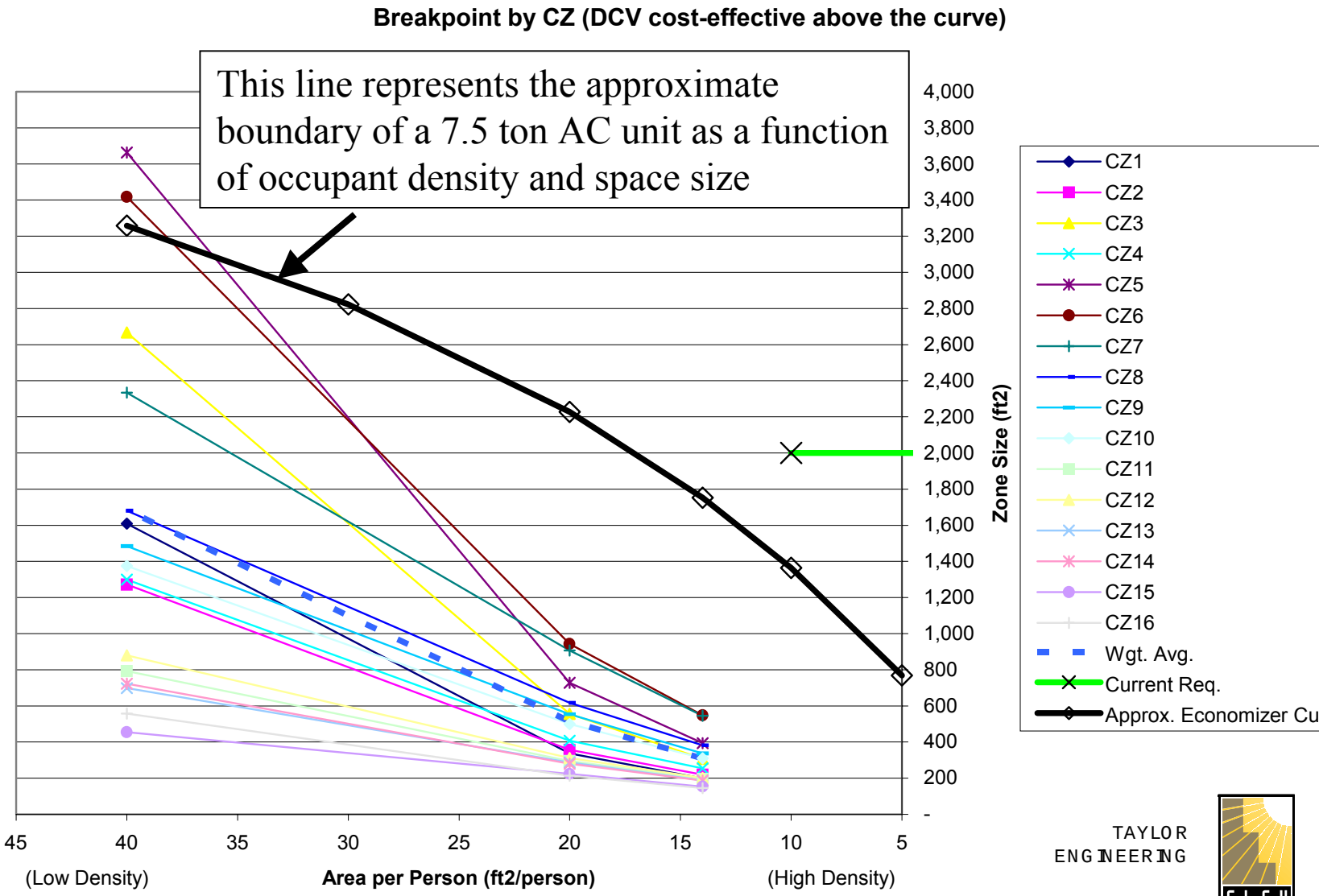
DCV Modeling Results



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DCV Discussion

- Air-side economizer costs not included in our analysis. They are already required by the standard under 144(e).
- Multiple-zone systems are exempt from this requirement:
  - It would require DDC to the zone level
  - There are no guidelines on how to cascade the terminal device and out-door air damper controls
  - PIER research is investigating the control issue

Questions